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BOARD # 455: Stimulating Interdisciplinary Graduate Research Across NSF-NRT Institutions

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Stimulating Interdisciplinary Graduate Research Across Institutions with a Rapid Proposal Design Workshop

Abstract. How do you find and develop research collaborations? What about collaborations across departments or even institutions? We have created a workshop and associated tools to help graduate students learn how to make connections with other researchers and efficiently generate interdisciplinary project ideas and teams. Through a multi-year collaboration between our two NSF NRT grant teams, both focused on harnessing Artificial Intelligence (AI) for advancing materials discovery, we have developed and implemented a Rapid Research Proposal Design Workshop to support cross-institutional, interdisciplinary research project development. This paper provides a step-by-step guide for workshop implementation that may be useful to other educators hoping to prepare and inspire junior researchers for interdisciplinary collaborations.

1. Introduction. The National Science Foundation's Research Traineeship program (NRT) supports graduate student professional development through cross-disciplinary content, team-based learning approaches, and interdisciplinary research. The demand for interdisciplinary research and skills has surged in the last decade, with U.S education policy emphasizing a need to transcend traditional disciplinary boundaries to address current and future global challenges [1] [2]. While all NSF NRT Programs have fully embraced interdisciplinary graduate research [3] [4] [5] [6], our efforts have extended to developing and maintaining strong collaborative bonds across institutional programs. While cross-instructional partnerships may take longer to start-up and require high levels of planning and communication, they are advantageous to complex research undertakings as they leverage existing research resources, strengthen investigator development and productivity, expand research opportunities, increase impact, and facilitate problem-solving [7]. Through a multi-year collaboration between our two NSF NRT grant teams [8], both focused on harnessing Artificial Intelligence (AI) for advancing materials discovery, we have developed and implemented a Rapid Research Proposal Design Workshop to support cross-institutional, interdisciplinary research project development.

The speed and scale of progress with advances in AI in recent years, our capacity to use data science and AI to find patterns and relationships in large data sets represents a scientific revolution that impacts many disciplines [9]. However, there are risks to research integrity and rigor when there is limited collaboration between AI experts and non-AI disciplines [9] . Our objective was to design an activity to support graduate student idea sharing and interdisciplinary collaboration. This activity gives students an opportunity to practice making connections with fellow researchers and generating research ideas to then screen and develop into proposals. The students can use the tools and approach practiced in the workshop again and again as they go on

to meet potential collaborators at their own institutions or while networking at conferences. We've successfully run this workshop at two joint NSF-NRT symposia "Harnessing AI for Materials" (3 participating NRTs in 2022 and 5 participating NRTs in 2024). The facilitated workshop for 45 students takes about 2 hours (Table 1).

2. Workshop implementation. 2.1 Team organization. The workshop facilitators have had access to student disciplinary background and research areas prior to the workshop. To organize the teams, we first attempted to organize the physical scientists and engineers based on either materials type (polymers, metals, ceramics) or application type (batteries, biomedical) and then distributed the math, computer science, and statistics students across groups so that each group had 3-5 members with at least one computational lead. Once teams were established and sitting together, students self-selected roles: timer, scribe, lead speaker roles. While many students may have been already acquainted through previous symposium events, they were asked to reintroduce themselves and share their research interests and computational approaches.

Table 1. Timeline for rapid proposal design activity

Activity	Time
Team Organization Select roles: timer, scribe, speakers Member introductions: sharing research interests and methods	15 min
Rapid Proposal Design Brainstorm research ideas Screening/identify top ideas What could you accomplish together to have the greatest impact? Develop top idea and prepare 1-slide visual	45 min
Presentations Practice presentation Speakers share-out 3 min each + Q&A	45 min
Reflection and wrap-up. Option for judging competition	15 min
Total	2 hours

2.2 Ideation and screening. Next, teams were asked to brainstorm project ideas and articulate a research approach. Students are tasked with generating at least five project ideas that applied machine learning to materials science questions. They had the option to source ideas from existing literature, through ChatGPT prompts, and through curated lists of priority research areas like The Materials Genome Initiative Challenges [10]. Teams then screened their ideas giving priority to those which had the greatest potential impact and that they could accomplish as a team and within the scope of a year. Teams were encouraged to explore their top two ideas further; asking what data sources were readily available. The existence, or lack, of clean and robust data

is a major limitation in these types of projects [11]. Students could decide to use existing data sets, collect experimental data, or generate data from various computational models.

2.3 Proposal development. We provided groups with a fill-in-the-blank proposal template to expedite the research idea development process (Figure 1), because we wanted to encourage high level thinking and not have the student groups too bogged down in the research details. We asked each team member to identify their expertise area and their potential contribution to the project. During this phase, faculty members circulated around the room to support teams and offer gentle guidance. After the design phase, we had teams present their ideas using one slide to support their pitch. Each team was given 3 minutes to share their idea and 3 additional minutes for audience questions.

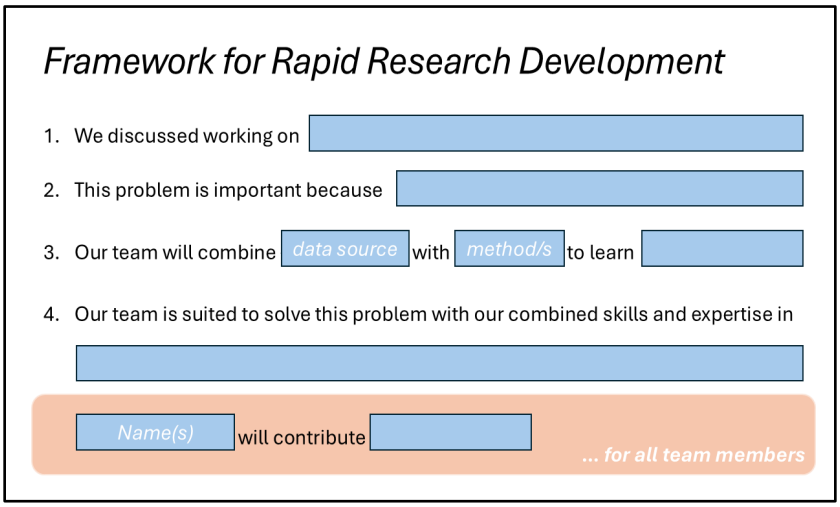

Figure 1. Template for research proposal development.

3. Reflections and lessons learned. The workshop framework promotes knowledge sharing, builds participant confidence for finding collaborators, and inspires fruitful collaboration between participants. Students were able to make new connections and face new challenges as they visualized how their knowledge and efforts align with other scientists and engineers. The first time we ran the workshop, the faculty advisors were impressed by the quality of the project ideas and presentations. We observed such excitement in the teams, but we had no formal mechanism to support the continued student collaborations beyond the workshop. We encouraged teams to pursue hackathon opportunities and organized online sessions to support team planning and project management. While the faculty teams continued to submit joint grant proposals, the student team interactions fizzled out. For the second iteration of the workshop, we provided an incentive for the teams to continue their collaboration and execute on their ideas. The faculty members evaluated the proposal presentations with the following criteria: 1. Clear statement of motivation; 2. Impact of materials-related research ideas; 3. Formulation of methods

including data source and computational approach; 4. Clear statement of team contribution to research; 5. Presentation quality. The winning 4- member team, representing 3 universities, was awarded travel funds to support their continued collaboration at a conference or hackathon. The winning project will explore the drug diffusion into engineered tissue scaffolds (Figure 2). They plan to submit their work to the 2025 NeurIPS AI for Accelerated Materials Discovery Workshop.

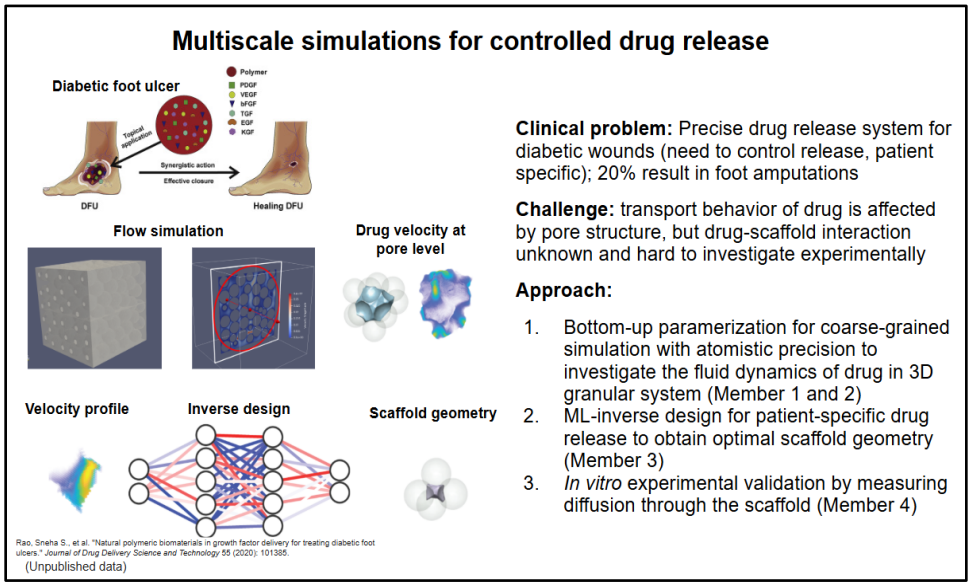

Figure 2. Slide from the winning proposal at 2024 workshop. Student names have been removed.

In summary, this workshop activity enhances student collaboration skills and produces tangible outcomes. One participant reflected, “The brainstorming session with people from different backgrounds really broadened my perspective. It was a great opportunity to learn from each other and propose a new idea within 30 minutes. It was challenging, but the joy of collaboration and the chance to open up new horizons made it a standout experience for me." We believe this activity is well-suited for use by other educators or researchers interested in building research community enthusiasm and preparing junior researchers for collaborations. We recognize that many scientific and engineering fields are increasingly teaming up with computational scientists and data experts and the workshop provides an opportunity to ease the challenge of working across technical domains. We find the fill-in-the-blank template particularly useful to provide a starting point for proposal development and have repurposed it for year-long project courses and lessons on research elevator pitches. Running the workshop also supported deeper connections between participating universities, building further institutional capacity for innovative graduate training, and aligning with core NRT objectives to strengthen interdisciplinary graduate education.

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